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USDA FOREST SERVICE RESEARCH PAPER PNW-115

LOGGING RESIDUES

ON DOUGLAS-FIR REGION CLEARCUTS
WEIGHTS AND VOLUMES

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ACKNOWLEDGMENTS

We wish to acknowledge the cooperation of the Forest Survey Project, Pacific Northwest Forest and Range Experiment Station, in making available data from a pilot study of clearcuts in western Washington. This project is continuing its study to provide estimates of usable logging residues in Washington, Oregon, and California. We appreciate the help of Gus Peterson, Check Scaler, Mount Hood National Forest, for his assistance in logging residue measurement; and the advice and instruction provided by George Harrington, Crown Zellerbach Corporation (Portland, Oregon) in determining log quality for chip utilization.

ABSTRACT

This paper presents the results of ground measurements of logging residue weights and volumes on 30 clearcut units in Douglas-fir forests of western Oregon and Washington. Additional information is given on quantities of material left as slash which might be utilized. These measurements were made on public lands, using a method developed in Canada.

Keywords: Slash disposal, cutting (harvest), forest fuels, fuelwood use, clearing operations.

INTRODUCTION

Even with today's improved standards of utilization, timber harvesting in the Douglas-fir region continues to produce large accumulations of smashed logs, limbs, tops, rotten wood, and broken-down underbrush littering the ground. These residues must be removed from logged units to allow ground space for regeneration, to eliminate obstacles to future harvesting, and to reduce the fire hazard. Also, residue accumulations may obstruct recreational opportunities and efficient forest management and, to many, represent both a depreciation of natural beauty and a waste of potentially usable wood products.

Foresters responsible for execution of postsale slash disposal and reforestation actions need to know more about the quantities, distribution, and characteristics of residues left on the ground after logging (fig. 1). This information can be used to more effectively prescribe stand treatment, determine sale utilization standards for the sale contract, and plan postsale fuel treatments and reforestation measures. Such information is an important component in determination of sale operational costs for use in stumpage appraisal and is of value to potential purchasers of salvage sales.

With this knowledge, the postsale forester has a better basis on which to make important decisions on whether to prescribe burn, plan relogging for utilization of substandard material,[1/] or to manage the fuels complex under an extra fire protection program until the hazard has abated. The line transect sampling method presented here will also be of interest to foresters. It is a relatively efficient way, considering both time and cost, to gather and assemble logging residue information. It could be readily used to gather additional local data to strengthen the data presented in this report for specific sale planning purposes.

To date, slash volume data available have been derived from fuels research in the California Region and therefore are not directly applicable to Douglas-fir cutover areas in Oregon and Washington forests. Sundahl (1966) made weight

[1/] *Substandard material consists of logs and pieces large enough to be usable but which are rotten and/or broken so that less than one-third of their contents is usable for sawed products. This material cannot be sold as saw logs but may be marketable, at reduced prices, for the production of chips.*

Figure 1.—The forester needs to know the amount and kind of residues left from logging if he is to make effective decisions on fuels management and utilization. This unit on the Hickman Lake sale, Mount Hood National Forest, contains 10,447 cubic feet of slash per acre, of which 3,778 cubic feet per acre could be utilized for chip material. Slash weights totaled 138 tons per acre.

measurements in slash and litter from two 90-year-old forest cover types at the Challenge Experimental Forest following clearcuttings. Ponderosa pine and ponderosa pine-Douglas-fir types in that area yielded 53-110 tons of slash per acre. These estimates were based on slash weight tables developed by Chandler (1960) from earlier work by Storey, Fons, and Sauer (1955). Chandler's tables refer to the five predominant species of the west-side mixed-conifer timber type in California. Fahnestock (1960), in appraising the potential fire hazard of slash in the northern Rocky Mountains, modified the California method to show crown weight (ovendry) as a function of diameter at breast height and crown length.

A fuel volume study in the Douglas-fir region by McArdle (1930) determined the volume of coarse debris (pieces more than 3 inches in diameter and 3 feet long) in cords per acre. He estimated slash amounts on individual plots from 17-137 cords per acre (approximately 25-185 tons per acre by our calculation). Hodgson

(1930) reported on an extensive study of logging wastes in the entire Douglas-fir region, including private, Federal, and State lands. He determined that over 3 billion board feet of cordwood or larger size was being left in the woods after logging.

In more recent years, study plans for slash volume measurements in the Douglas-fir region were undertaken by Scott[2/] and by Hendee and Kreiss,[3/] but studies were not completed.

A very recent method developed in Canada is the inventory of slash fuels using 70-mm. low-level photography. According to Muraro (1970), fuel loadings calculated from measurements on 70-mm. photography are equally as reliable as those obtained from ground sampling methods.

Surveys of utilizable logging residuals were conducted by the Washington Institute of Forest Products in 1950 (State of Washington 1950) and by the U.S. Department of Commerce in 1963 (U.S. Department of Commerce 1964). Their data indicate a wide range of usable wood per acre left after logging and an average of over 20 percent of the original stand remains on site as potentially utilizable material.

Our paper presents the results of ground measurements of coarse logging residue weights and volumes on 30 clearcut units on public lands in western Oregon and Washington.

SAMPLING PROCEDURE

A line intersect method derived by Warren and Olsen (1964) in New Zealand, and modified by C. E. Van Wagner (1968), was used in selecting the sample of volumes and weights of logging residues on all units in this study. Only *coarse* residues (pieces 4 inches and larger) were measured in the study. Weights for *fine fuels* (needles, twigs, small limbs, splinters, and other small fragments) were not determined. This material can be sampled only by collecting and weighing fuels on narrow strips or small plots within the slash complex. Munger and Matthews (1941) determined that fine fuels in Douglas-fir slash plots averaged 64 cords per acre, or 38.5 tons. We estimated the fine fuels on our study areas ranged from 20-40 tons per acre in addition to the measured tonnages shown in table 1.

Thirty clearcut units were sampled. On 16 of the clearcuts, two transect lines crossing at about right angles were located in the units to give the best estimates of the residue volumes. The lengths of the lines varied from 2,000 feet to 3,400 feet per unit, depending on the diagonal distances across the units as shown in figure 2.

Volume data for the remaining 14 units were provided by a

[2/] *Norman C. Scott. Slash volume sampling study. Study plan on file at USDA Forest Serv., Pac. Southwest Forest & Range Exp. Sta., Forest Fire Lab., Riverside, Calif., 1964.*

[3/] *John C. Hendee and P. R. Kreiss. Look at some logging slash fuel weights in second-growth Douglas-fir on the Siuslaw National Forest. Unpublished manuscript on file at USDA Forest Serv., Pac. Southwest Forest & Range Exp. Sta., Forest Fire Lab., Riverside, Calif., 1965.*

Table 1.--*Residue weights and volumes on units measured in this study*

Unit	Forest	State	Township	Range	Acres	Type of logging	Volume		Weight	
							Gross	Net[1/]	Gross	Net[1/]
							Cubic feet per acre		*Tons per acre*	
Huckleberry #1	Mount Baker	Wash.	33N	11E	18	High-lead	2,900	2,091	40	27
Ditney #2	Mount Baker	Wash.	31N	7E	74	High-lead	9,087	2,895	122	39
Double Eagle #2	Mount Baker	Wash.	30N	10E	54	Skyline	5,348	1,771	72	24
West Copy #2	Snoqualmie	Wash.	28N	12E	25	High-lead	6,494	2,648	87	35
Money Creek #4	Snoqualmie	Wash.	26N	10E	64	High-lead	8,006	4,045	108	54
Cold #4	Gifford Pinchot	Wash.	11N	9E	54	High-lead	6,000	2,103	80	28
Spring #1	Gifford Pinchot	Wash.	10N	10E	53	High-lead	3,513	1,558	47	21
Guard #1	Gifford Pinchot	Wash.	10N	7E	26	High-lead and tractor	5,362	2,984	72	41
Clear Creek #5	Gifford Pinchot	Wash.	9N	7E	45	High-lead	7,455	3,143	100	42
Twin Falls #13	Gifford Pinchot	Wash.	8N	9E	47	Tractor	5,080	*	70	*
Poison Creek #1	Gifford Pinchot	Wash.	8N	8E	45	Tractor	5,077	*	70	*
Poison Creek #2	Gifford Pinchot	Wash.	8N	8E	55	Tractor	6,896	*	95	*
Poison Creek #3	Gifford Pinchot	Wash.	8N	8E	55	Tractor	8,804	*	121	*
Valley #1	Gifford Pinchot	Wash.	8N	7E	36	High-lead	7,773	4,462	104	60
Peak #3	Gifford Pinchot	Wash.	7N	7E	55	High-lead	8,593	3,474	115	47
Silver Dungeness #2	Olympic	Wash.	28N	4W	35	High-lead	3,417	2,288	46	31
South Fork Skokomish L-35	Olympic	Wash.	23N	5W	46	High-lead	2,405	1,733	32	23
Cook Creek #1	Olympic	Wash.	22N	10W	129	High-lead	8,779	2,974	118	40
Section 8	Quinalt Indian Reservation	Wash.	23N	11E	150	High-lead	18,634	*	227	*
Upper Wash Creek #3	Mount Hood	Oreg.	6S	5E	100	High-lead	14,390	7,472	191	100
South Fork Mountain #4	Mount Hood	Oreg.	6S	5E	100	High-lead	6,112	2,208	80	29
Hickman Lake #5	Mount Hood	Oreg.	1S	7E	38	High-lead	10,447	3,778	138	50
Hospital Creek #1	Willamette	Oreg.	20S	2E	31	High-lead	6,026	*	79	*
Hospital Creek #2	Willamette	Oreg.	20S	2E	43	High-lead	9,241	*	121	*
Hospital Creek #3	Willamette	Oreg.	20S	2E	40	High-lead	8,830	*	116	*
Hospital Creek #4	Willamette	Oreg.	20S	2E	20	High-lead	8,763	*	115	*
Bruno Mountain #15	Willamette	Oreg.	10S	7E	14	High-lead	13,663	*	180	*
Bruno Mountain #16	Willamette	Oreg.	10S	6E	14	High-lead	11,219	*	147	*
Bruno Mountain #18	Willamette	Oreg.	10S	6E	17	High-lead	7,000	*	92	*
Twin Lakes Ridge #9-1	Umpqua	Oreg.	27S	2W	26	High-lead	6,236	*	82	*

[1/] Chippable material.

* Not measured.

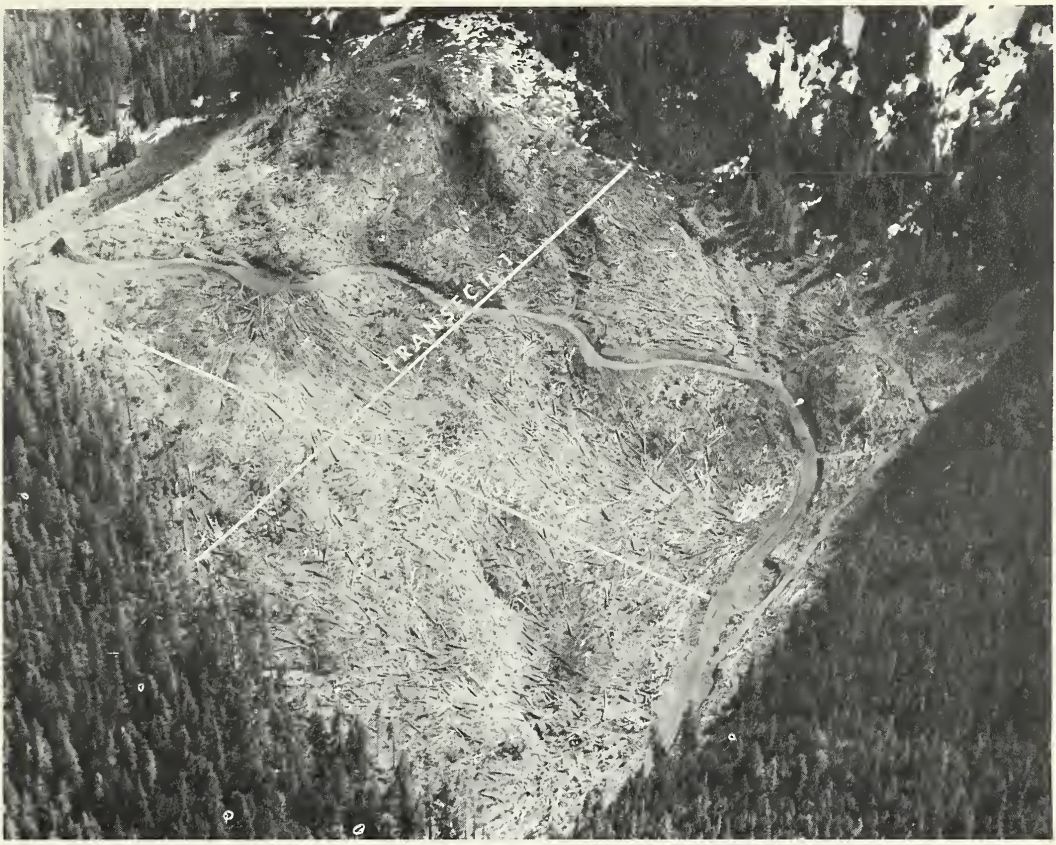

Figure 2.—On 16 of the 30 clearcuts sampled, two transect lines crossing at right angles (as shown above) were located in the units. This is the 100-acre Upper Wash Creek Unit, Mount Hood National Forest. It contained 14,390 cubic feet of residues per acre, with 7,472 cubic feet per acre of material which could be chipped if it could be removed. The unit had 191 tons of residues per acre.

research team from the Forest Survey Project, of the Pacific Northwest Forest and Range Experiment Station, as part of a pilot study on utilization of residues.[4/] These units were sampled by a 30-chain continuous transect, taken in 5-chain segments, along randomly chosen azimuths located within each clearcut unit. Figure 3 is an aerial view of one clearcut, with the directions of the lines indicated.

[4/] *Forest Survey Project. Operating plan for a pilot study of the amount and kind of residues left after clearcut logging on the National Forests of western Washington. Unpublished study plan on file at USDA Forest Serv., Pac. Northwest Forest & Range Exp. Sta., Portland, Oreg., 1969.*

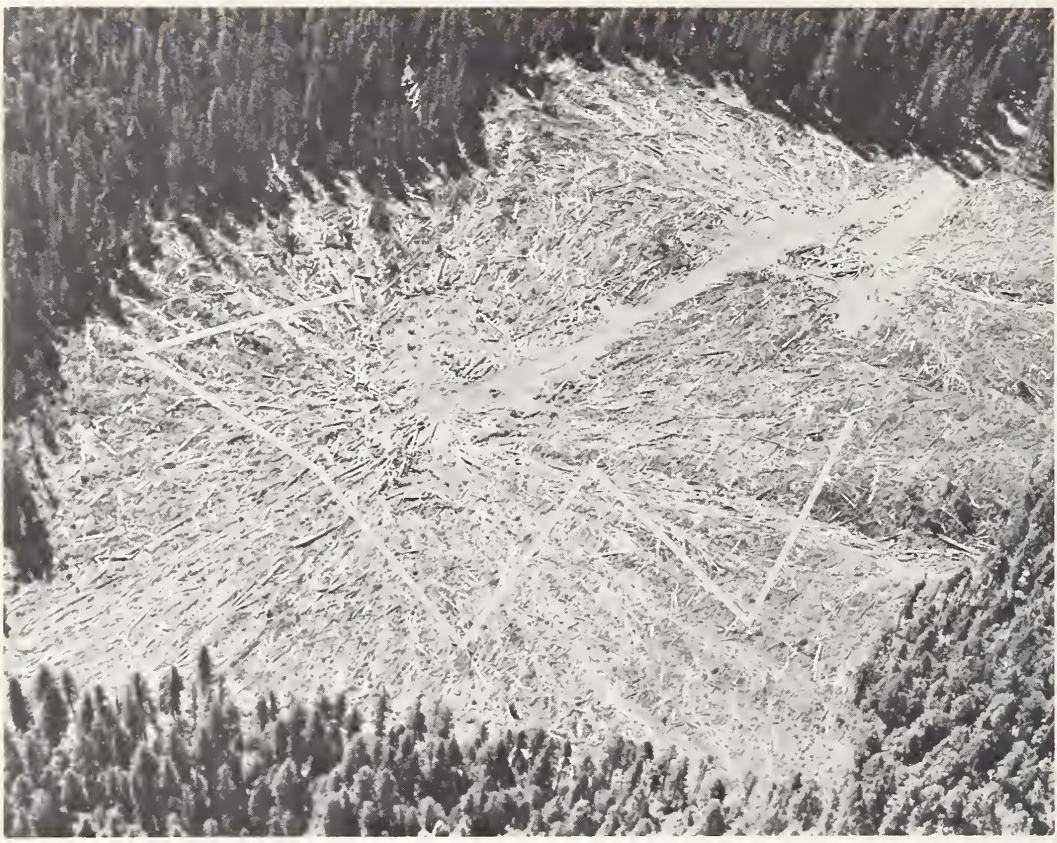

Figure 3.—The 14 units measured by the Forest Survey team were sampled by a 30-chain continuous line transect, taken in 5-chain segments, along randomly chosen azimuths located within the clearcut (as shown in this aerial view).

Diameters were recorded of all pieces intersected by the transect lines. On 17 of the units (14 sampled by the Forest Survey Project and 3 by us), logs suitable for pulp chips were recorded separately from those pieces considered waste material only. Utilization standards for chippable logs vary considerably between companies in the Northwest pulp markets. Foresters planning to sample residues for chip utilization should obtain local criteria in applying this method. The criteria we used for the units on which we measured chippable material (Upper Wash Creek #3, South Fork Mountain #4, and Hickman Lake #5) was that a chip log be at least 50 percent sound, 6-inch diameter (small end), and 12-foot length. The criteria used by the Forest Survey team on the 14 units they

measured was that a chip log be at least 10 percent sound, 5-inch diameter (small end), and 4-foot length.

On the remaining 13 units no differentiation was made between waste and chippable material in the residues complex.

Logging residue volumes were determined by using the equation

$$V = \frac{0.00857 \Sigma d^2}{L} \quad (43,560)$$

where

V = volume in cubic feet per acre
d = diameter of logs in inches
L = length of transect line in feet

The equation used for finding residue weights in tons per acre was

$$W = \frac{11.65 S \Sigma d^2}{L}$$

where

S = specific gravity[5/]

RESULTS

A total of 1,509 acres were sampled in this study. Table 1 provides a summary of logging residue weights and volumes on the 30 units sampled. Species composition of residues was almost entirely Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*) and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.), except for the Quinault Indian Reservation (Olympic Peninsula) where the slash was entirely western redcedar (*Thuja plicata* Donn). The mean gross volume of residues on 27 of the 30 units sampled was 7,430 cubic feet per acre with a standard error of the mean of 8.7 percent (651 cubic feet).[6/] The volume of logging residues suitable for manufacture of pulp chips (based on the criteria described), on the 17 units on which such residues were sampled, averaged 45 percent of the gross volume.

Slash fuel weights (usable and nonusable residues combined) ranged from 32 tons per acre (South Fork Skokomish Unit, Olympic National Forest) to the 227 tons per acre encountered on the Quinault Indian Reservation (fig. 4).

DISCUSSION AND CONCLUSIONS

The data presented give an indication of the large volumes and tonnages of logging residues being left in the Douglas-fir forests of the Northwest. It is such volumes as these that have prompted increased attention to residue management programs and to providing opportunities for better utilization.

[5/] *Specific gravity (at 12 percent moisture content) was taken from Wood Handbook, Agr. Handb. No. 72, Forest Prod. Lab., USDA Forest Serv. (table 12, p. 70-77), 1955.*

[6/] *Three of the units (Upper Wash Creek #3, South Fork Mountain #4, and Hickman Lake #5) were measured to a 6-inch diameter limit instead of 4 inches. Because of this, they are not included in our calculation of the standard error of the mean.*

*Figure 4.—Some of the heaviest concentrations of logging residues encountered in western Oregon and Washington were found on lands of the Quinault Indian Reservation, on the Olympic Peninsula in western Washington. One slash fuel complex, like that in the photo above, contained 18,634 cubic feet of residues per acre, or 227 tons of fuel per acre. The wood species on this area is almost completely western redcedar (*Thuja plicata *Donn).*

A number of National Forests in Oregon, Washington, and northern California are experimenting with contract reyarding or clean-logging of cutting units instead of broadcast slash burning. In the process, chippable logs are selected, cable or tractor yarded, loaded, and hauled to the nearest chipping plant for processing. Remaining unutilizable debris is yarded into large piles (fig. 5) for burning when smoke dispersal conditions are most favorable. This modifies the slash hazard and reduces potential smoke problems from large-scale broadcast burning. Such residue reduction programs are contingent, of course, on usefulness of species for chips, current market conditions, and proximity of the logging unit to the processing plant.

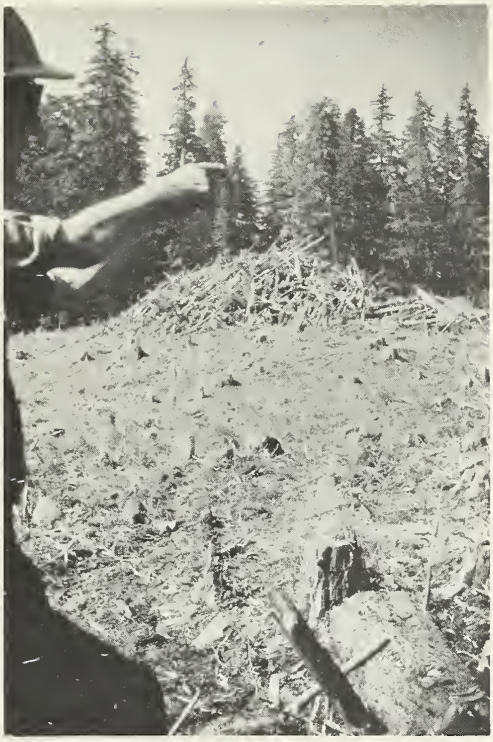

Figure 5.—This clearcut slash area has been cleaned of larger fuel by high-lead yarding. Unutilizable material is yarded to concentrated piles, such as this one, for burning when smoke dispersal conditions are most favorable.

The presale forester should be alert for possible residue utilization on timber sales where cruise data indicate a relatively high percent of defect in a species useful for chips. Further study is needed to determine just what relationship actually exists between percent of defect estimates and actual volume of logging residuals--and if these can be correlated to provide a reasonably accurate presale estimate of potential residual utilization.

Study is also needed to determine the total magnitude of logging residues developed in the Douglas-fir region and their distribution by species, size, and suitability for pulping. Since we commenced work on this paper, such studies have been undertaken.

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Keywords: Slash disposal, cutting (harvest), forest fuels, fuelwood use, clearing operations.

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